Tests on Combined Staged Combustion, SNCR & Reburning for NO_x Control and Combined NO_x/SO_2 Control on an Industrial & Utility Boilers

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According to DOE-EIA, in 2002 the national average NO_x emission from coal-fired power plants was 0.5 lb/MMBtu, resulting in nationwide emissions of 4.47 million tons. The New Source Performance Standard, (NSPS) set by EPA limits NO_x emissions to 0.15 lb/MMBtu, which equals to a national reduction of 3.13 million tons. This can now be achieved with very costly SCR, at about $75/kW, or by combining low-NOx burners, over-fire air, SNCR and reburn, costing about $2,000 per ton of NO_x removed.

NO_x and SO_2 emission control were an integral part of Coal Tech's decade long R&D effort, that was partly supported by DOE and ended in 1997, to develop a coal-fired, 20 MMBtu/hr slagging combustor that was attached to an oil/gas industrial boiler. With staged combustion, NO_x emissions were reduced from an uncontrolled range of 0.8/1.1 lb/MMBtu to 0.26/0.4 lb/MMBtu with staged combustion.

Beginning in 1997, Coal Tech began an extensive test effort, solely with internal resources, to develop very low-cost, post-combustion SNCR and reburn processes to essentially eliminate the remaining NO_x emissions. With staged, fuel rich primary combustion and SNCR injection, using a novel injection procedure into the fuel-rich, post-combustion zone, the combined NO_x reduction was 93%, from 1 lb/MMBtu to 0.07 lb/MMBtu. Without staged combustion and identical SNCR injection. 80% reduction to 0.2 lb/MMBtu was measured.

Also between 1997 and 2003, Coal Tech tested its SNCR post-combustion process on three coal-fired utility-boilers, rated at 37 MW, 50 MW and 100 MW. Each test series was implemented with improved injectors. They were inserted into the boiler through existing access ports, eliminating the need for new boiler wall penetrations. The test objective was to maximize the interaction between the NO_x in the combustion gas and the injected reagent solution. Typical of the most recent tests on the 50 MW-boiler was the measured NO_x reduction of 46%, from an initial 0.28 lb/MMBtu, obtained with the existing fuel rich combustors and overfire air, to 0.15 lb/MMBtu obtained with Coal Tech's SNCR process. Reagent utilization efficiency in this test was 78%, resulting in a SNCR process cost of about $400 per ton of NO_x removed. The estimated installed capital cost of this process is several dollars per kW.

Also, during this period, numerous tests were conduced on Coal Tech's NO_x reburn process in the 20 MMBtu/hr, combustor-boiler using No.2 oil or shredded biomass as the post-primary combustion reburn-fuel. Various injector designs and fuel injection locations were tested. The peak measured NO_x reduction was 50%. These fuels were selected in order minimize the cost of these Coal Tech financed tests. However, similar results are anticipated with this process when coal is used as the reburn fuel. As with the SNCR process, this reburn

process is implemented without boiler modifications, which limits its installed capital cost to the same level as the SNCR process, namely a few dollars per kW. Since these staged combustion, SNCR and reburn processes are additive, the addition of the reburn process to the 50 MW boiler, for example, would reduce NO_x to well **below 0.1 lb/MMBtu**.

The SNCR injection process was also combined with Coal Tech's post-combustion SO_2 reduction using calcium based reagents. In tests in the 20 MMBtu/hr facility, reductions as high as 80% for each of the two pollutants were measured. Initial tests of this process were also conducted several years ago on the 50 MW-boiler with an early version of the injector design. While the NO_x results were essentially identical to the obtained with SNCR alone, operational problems with the design used resulted in lower SO_2 reductions than those obtained in the 20 MMBtu/hr-combustor-boiler. The new design eliminated these problems. Prior to implementing further tests on the 50 MW boiler, tests are currently in progress to further reduce the process costs to well under $100 per ton of SO_2 removed. The capital costs of this combined process is in the same range as the SNCR process, namely several dollars per kW.

Finally, these NO_x and SO_2 processes are an integral part of Coal Tech's R&D effort to totally eliminate emissions from coal combustion, which includes processes for the removal of volatile trace metals, such as mercury and arsenic, dioxins/furans, and carbon dioxide.